Improving Remote Sensing of Coastal Regions: Signature of Inundation Area on Passive Microwaves

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PMM Meeting, 2015, Baltimore, Maryland

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Motivation

- River deltas are lowland areas at the land-water interface. They are vulnerable to climate and human actions (local subsidence, sea level rise, and upstream anthropogenic activities that reduce the water and sediment delivery that feeds the deltaic surface).
- Deltaic systems also experience extreme tropical storms that result in flooding, storm surges, and catastrophic loss of property and life.
- Ground-based precipitation data are not available for these regions and GPM offers unique opportunities but also challenges due to land surface heterogeneities and complex issues arising at intricate land-water interfaces.

Challenges in Precipitation Retrieval over coastal zones:

- In deltaic regions, the presence of water is not permanent due to the seasonal variations or tidal effects and presence/absence of flooding.
- Due to the interference of land-ocean background radiation, rainfall retrieval over deltaic zones is naturally very complex.
- The 2A12 standard product uses a physically constrained retrieval approach over ocean (Kummerow et al. 2011) while it remains empirical over land (e.g., Gopalan et al., 2010). The transition between these two retrieval approaches makes the results of retrieved precipitation over coastal regions less accurate than over other surface categories.
- The ShARP retrieval uses a constrained shrinkage estimator to impose sufficient regularization to solve the ill-posed retrieval problem and promises improved retrievals at the vicinity of coastal areas. The a priori collected databases, i.e. dictionaries, contain coincidental information of the observed/simulated spectral brightness temperatures and their corresponding rainfall profiles (Ebtehaj et al. 2015).

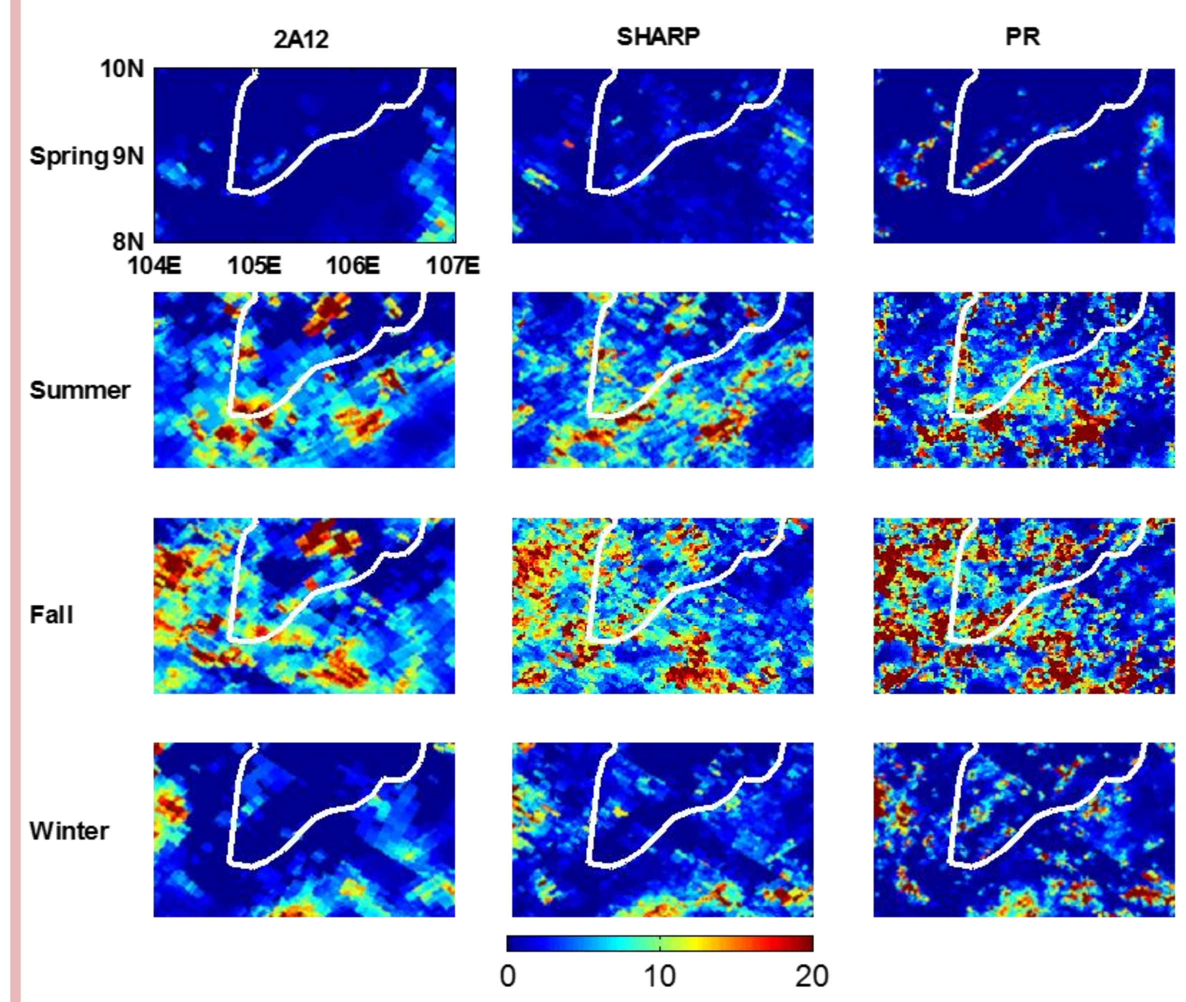
Objectives

- Study the signature of inundation on spectral brightness temperatures using the TMI channels.
- Derive a TMI-based surrogate for inundation (presence/absence and percentage of the inundated periods)
- Derive new inundation models using microwave frequency channels of GMI.
- Incorporate the above surrogate into rainfall retrieval algorithms and examine the performance (accuracy and uncertainty) in retrieving rainfall over land-water interfaces and inundated areas

Rational

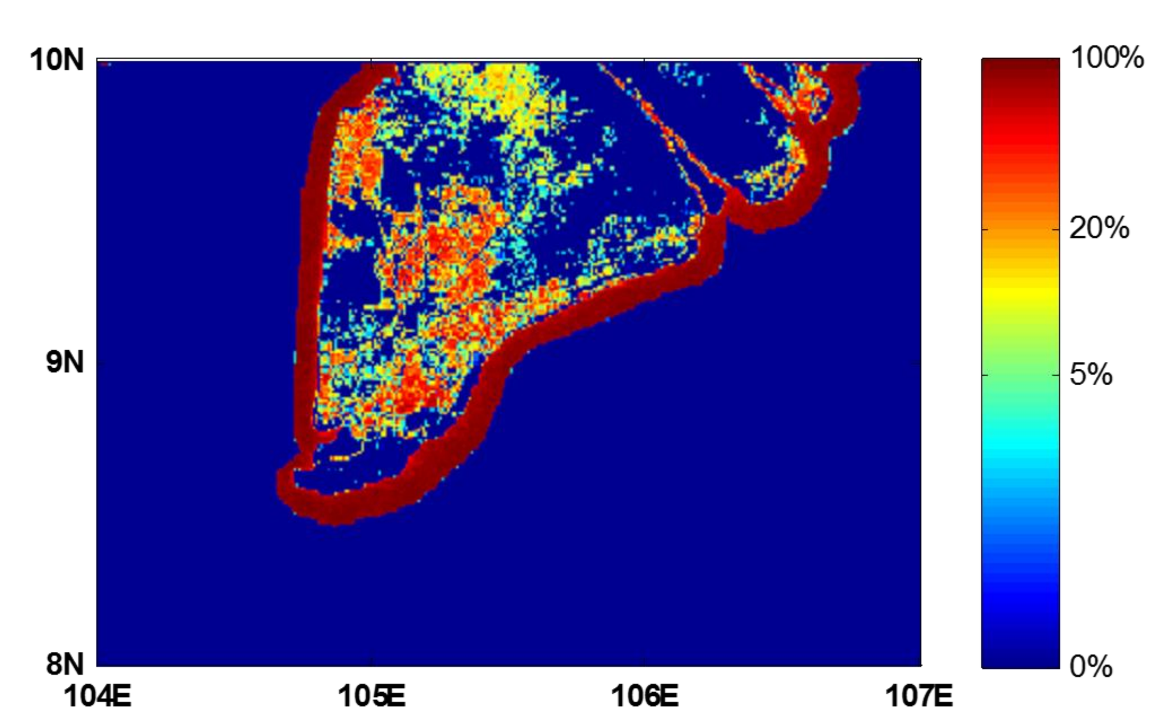
- Land inundated areas are often dynamic in space and time and change at temporal scales smaller than the 14-day average of MODIS products and spatial scales smaller than the TMI footprint of 5 by 5 km pixel (e.g. tidal channels, flood inundation, surges, etc.)
- For GPM precipitation retrieval, a TMI-based indicator of inundation can constrain the inversion e.g. by using an inundation-specific dictionary for retrieval.

Total seasonal rainfall over Mekong delta in 2013



- Precipitation Retrieval is complicated over the coastal regions due to the dynamic presence of inundated areas which causes transient structure of the background radiation.
- Good agreement between the ShARP retrieval and PR (2A25) in Summer, Fall, and Winter.
- In Spring, ShARP retrieves much larger areas of light rain over the land.
- Compared to 2A12, ShARP can better capture the fine structure of extremes surrounded by the lighter rains.

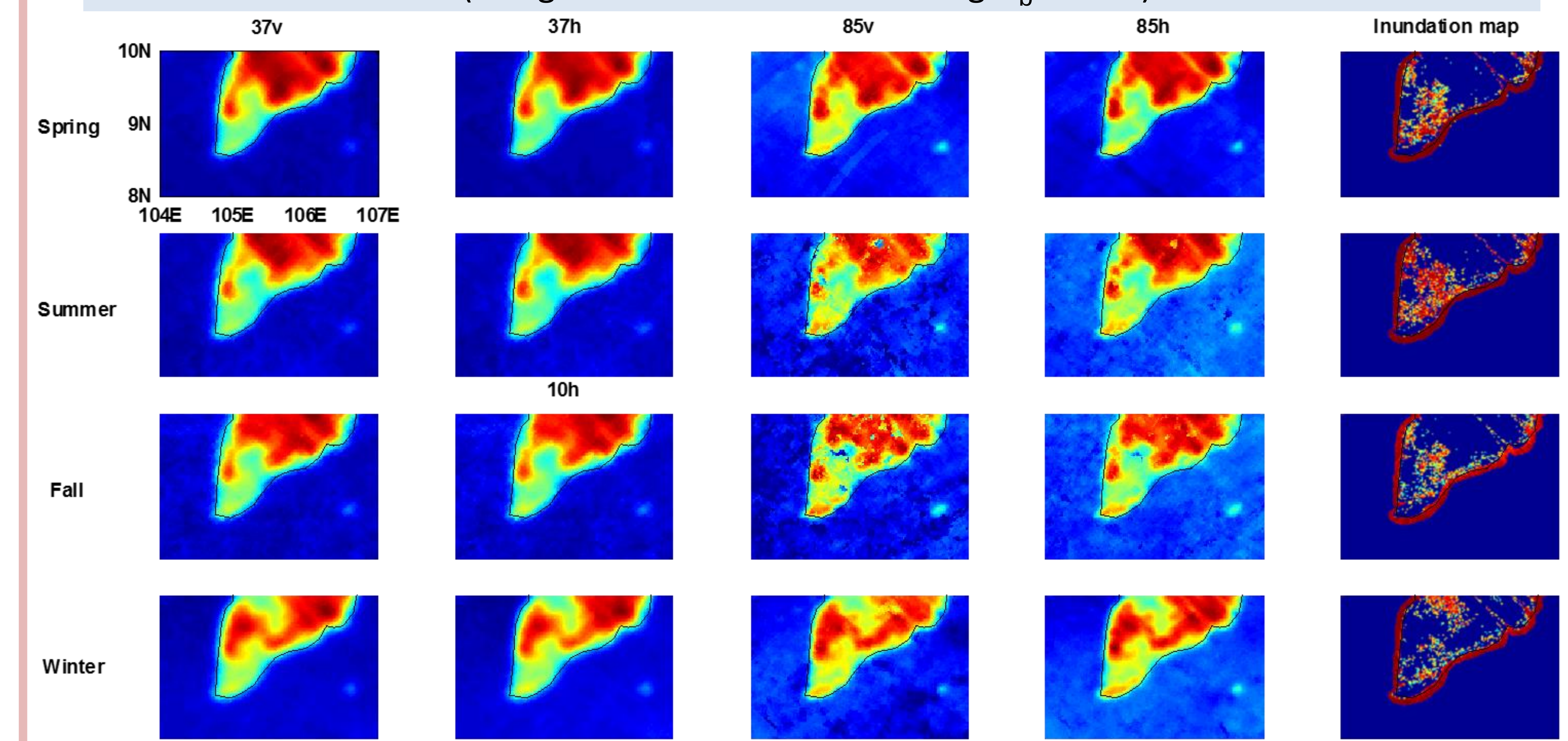
Inundation Map



Mean annual Inundation map for the Mekong delta based on 14-day MODIS NRT inundation data. This map demonstrates the percentage of time each pixel has been inundated in the year 2013.

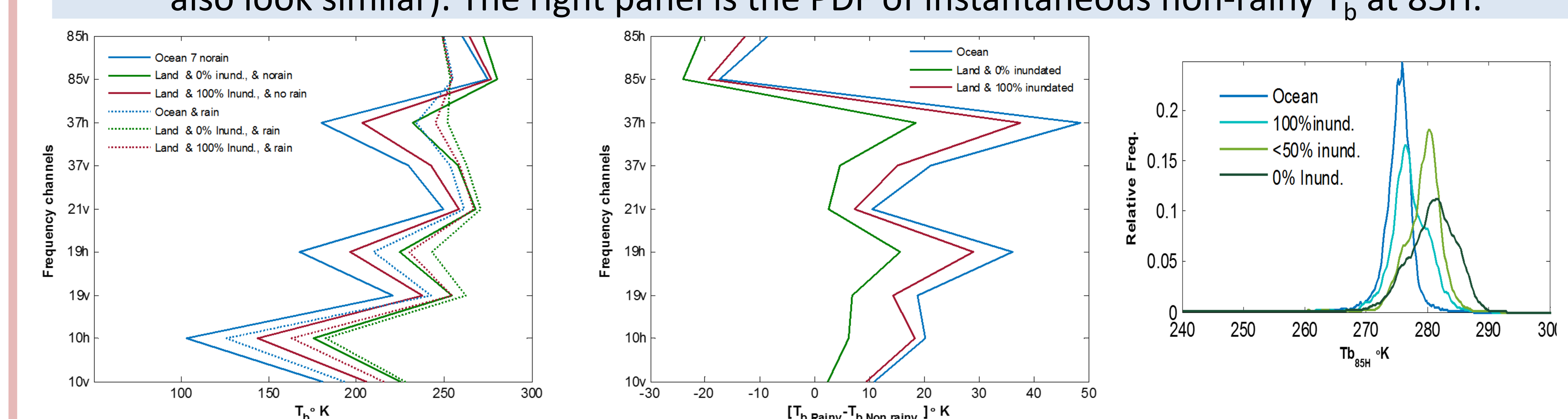
Seasonal brightness temperature (1B11-TMI)

Maps of mean seasonal overpasses of T_b at 4 frequency channels for clear sky (using PR-2A25 to remove raining T_b values):



- Inundated areas and coastlines are negatively correlated to the T_b of the corresponding pixels in the passive microwave images.
- The responses of all channels except 10v and 10h are similar in the mean seasonal T_b images over coasts and inundated areas (not shown here)
- The 85v and 85h are the most responsive because of their finer spatial resolution at the seasonal scale.

Left an Middle panels: mean instantaneous T_b for Summer season (all the other seasons also look similar). The right panel is the PDF of instantaneous non-rainy T_b at 85H.



- The most significant shift from no rainy to rainy T_b is for Ocean pixels, as expected.
- Rain makes the mean seasonal T_b warmer except for the 85 frequency channels
- The increase in the T_b of rainy vs non-rainy pixels for inundated pixels is larger than that of dry land pixels – this is because inundation decreases the brightness temperature of the corresponding pixels and the rain signature possibly can be detected better.

Conclusion

- T_b 85V or T_b 85H can be used as a surrogate of inundation
- Among all the frequency channels T_b 10V or T_b 10H have the least information about inundation areas compared to other 7 frequency bands.
- Knowing the inundation spectral signatures on instantaneous T_b values, may allow us to improve precipitation over coastal areas.
- This research will be continued to apply an appropriate clustering tool to delineate flood boundaries at the coastal regions at different time scale.

Acknowledgments and Reference

This research is supported by : NASA, NNX13AG33G Grant.

14-Days Inundation data over the Mekong Delta have been provided by Dan Slayback and Frederick S Policelli in NRT Global Flood Mapping group.

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